Santa Clara Valley Water District

FINAL

Groundwater Monitoring Plan

Indirect Potable Reuse Groundwater Studies

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Prepared for:
Santa Clara Valley Water District

Prepared By:

TODD GROUNDWATER
2490 Mariner Square Loop, Suite 215
Alameda, CA 94501
510 747 6920
toddgroundwater.com

SIGNATURE PAGE

CERTIFIED HYDROGEOLOGIST
SALLY
McCRAVEN
No. 356
Exp. 12/31/18
STATE OF CALIFORNIA

Sally McCraven

Sally McCraven, PG, CHg, CEG
Principal Hydrogeologist

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List of Acronyms

ASTM	American Society for Testing and Materials
DBCP	1,2-dibromo-3-chloropropane
DDW	State Water Resources Control Board, Division of Drinking Water
$CaCO_3$	calcium carbonate
CCR	California Code of Regulations
CECs	constituents of emerging concern
cis-1,2-DCE	cis-1,2-dichloroethylene
CTC	carbon tetrachloride
2,4-D	2,4-dichlorophenoxyacetic acid
DBCP	1,2-dibromo-3-chloropropane
1,1-DCA	1,1-dichloroethane
1,3-DCA	1,2-dichloroethane
1,2-DCB	1,2-dichlorobenzene
1,4-DCB	1,4-dichlorobenzene
1,1-DCE	1,1-dichloroethylene
1,2-DCP	1,2-dichloropropane
1,3-DCP	1,3-dichloropropene
DDW	Division of Drinking Water
DEET	n,n-diethyl-meta-toluamide
District	Santa Clara Valley Water District
DO	dissolved oxygen
EC	electrical conductivity
EDB	ethylene dibromide or 1,2-dibromomethane
ELAP	Environmental Laboratory Accreditation Program
ft-bgs	feet below ground surface
Freon 11	trichlorofluoromethane
Freon 12	dichlorodifluoromethane
Freon 113	1,1,2-trichloro-1,2,2-trifluoroethane
GRRP	Groundwater Replenishment Reuse Project
HAA5	Haloacetic acid (five)
HCO_3	bicarbonate
HDPE	high-density polyethylene
IPR	indirect potable reuse
MBAS	foaming agents (methylene blue activated substances)
MCL	maximum contaminant level
MFL	million fibers per liter

mg/L	milligrams per liter
MIBK	methyl isobutyl ketone
MPN/100 mL	most probable number per 100 milliliters
MTBE	methyl-tert-butylether
NDEA	n-nitrosodiethylamine
NDMA	n-nitrosodimethylamine
NDPA	n-nitrosodi-n-propylamine
ng/L	nanograms per liter
NL	notification level
OH	hydroxide
OOP	Operations Optimization Plan
ORP	oxidation-reduction potential
PCBs	polychlorinated biphenyls
PCE	tetrachloroethylene
pCi/L	picocuries per liter
PFASs	Perfluoroalkyl Substances
PPCPs	Pharmaceutical and Personal Care Products
QA/QC	Quality Assurance and Quality Control
RL	reporting limit
RRT	response retention time
RWC	recycled water contribution
SCVWD	Santa Clara Valley Water District
SFBRWQCB	San Francisco Bay Regional Water Quality Control Board
SM	Standard Method
SSOPs	Standard Operating Procedures
SWRCB	State Water Resources Control Board
TBA	tertiary butyl alcohol
1,1,1-TCA	1,1,1-trichloroethane
1,1,2-TCA	1,1,2-trichloroethane
1,1,2,2-TCA	1,1,2,2-tetrachloroethane
1,2,4-TCB	1,2,4-trichlorobenzene
2,3,7,8-TCDD	Dioxin
TCE	trichloroethylene
1,2,3-TCP	1,2,3-trichloropropane
TOC	total organic carbon
TDS	total dissolved solids
TKN	Total Kjeldahl Nitrogen
TNT	2,4,6-trinitrotoluene

Todd	Todd Groundwater
2,4,5-TP	Silvex
Trans-1-2-DCE	trans-1,2-dichloroethylene
TSS	total suspended solids
TTHM	Total Trihalomethanes
ULL	ultra low level
µg/L	micrograms per liter
µm	micrometers
USEPA	United States Environmental Protection Agency
WRRs	Water Reclamation Requirements

1 Introduction

Groundwater monitoring at recycled water recharge sites is required by State Water Resources Control Board (SWRCB), Division of Drinking Water (DDW) regulations as described in the following section. In addition, the Santa Clara Valley Water District (District), the potential Indirect Potable Reuse (IPR) Project Sponsor, actively manages the groundwater basins in Santa Clara County with the objective that groundwater is protected from existing and potential contamination. The District Board has adopted Ends Policies that provide direction to staff on the intended results, organizational products, impacts, benefits, outcomes, recipients, and their relative worth. The following Ends Policies are relevant to recycled water recharge projects and monitoring:

- Aggressively protect groundwater from the threat of contamination and maintain and develop groundwater to optimize reliability and to minimize land subsidence and salt water intrusion.
- Protect, maintain, and develop recycled water.

The DDW-required groundwater monitoring program is intended to provide a characterization of receiving groundwater quality prior to recycled water recharge and an early warning (prior to impacts to a potable water supply well) of any potential degradation of groundwater quality resulting from recharge of off-specification recycled water. The advanced-treated recycled water and groundwater will have different chemical signatures and the groundwater quality monitoring program will also provide data to better understand any changes in groundwater chemistry associated with recycled water recharge and the estimated movement of the recycled water in the subsurface. The monitoring wells will also be used to verify model-estimated subsurface travel time during DDW-required tracer testing.

Also, per the DDW regulations, the IPR Project Sponsor must submit an Operations Optimization Plan (OOP) to DDW and the local RWQCB for review and approval. At a minimum, the OOP must identify the operations, maintenance, analytical methods, and monitoring necessary for the project to meet regulatory requirements, as well as the reporting of monitoring results to DDW and RWQCB. The groundwater monitoring plan will be one component of the OOP.

2 Groundwater Monitoring Program

2.1 DDW Monitoring Well Requirements

The IPR Project Sponsor must site and construct at least two monitoring wells downgradient of the Groundwater Replenishment Reuse Project (GRRP) to comply with California Code of Regulations (CCR) Title 22, Sections §60320.126 (surface application) and §60320.226 (subsurface application) of DDW regulations related to replenishment with recycled water. One monitoring well must be located between two weeks and six months' travel time through the saturated zone downgradient of the GRRP and at least 30 days upgradient of the nearest drinking water well, and a second monitoring well must be located between the GRRP and the nearest downgradient drinking water well. The monitoring wells must allow for samples to be obtained independently from each aquifer used as a source of drinking water that will receive GRRP recharge water. The wells must be validated as receiving recharge water from the GRRP during tracer testing conducted within three months of GRRP startup, or under conditions simulating active GRRP operations. For planning purposes, analytical or numerical groundwater modeling may be used to predict travel times for monitoring well siting.

2.1.1 District Monitoring Well Plan

To satisfy these requirements, the District will install at least two multi-completion monitoring wells downgradient of each GRRP. GRRPs currently under consideration include advanced-treated recycled water (purified water) recharge in the existing Los Gatos Ponds (Los Gatos Ponds GRRP), in the existing Ford Pond and potentially in a new adjacent pond(s) (Ford Ponds GRRP), and in a network of injection wells located in the Campbell and San Jose area (Injection Wells GRRP). The monitoring wells will be sited based on travel times predicted through groundwater flow modeling (Todd, 2017a and b). The monitoring well screened intervals will be determined based on the method of recharge (surface or subsurface), screened interval of injection and nearby water supply wells, and conditions encountered during drilling.

For established GRRP projects, monitoring wells have focused on the portion of the GRRP recharge area upgradient of the nearest potable supply well (based on travel time) rather than all potential flow pathways away from the GRRP and all downgradient potable supply wells. Accordingly, the initial monitoring wells installed to date for the potential Los Gatos Ponds GRRP are focused between the ponds (Budd Ponds) located closest to the nearest potable supply wells (07S01W27P009 and 07S01W27Q001). To date, five depth-discrete monitoring well casings have been installed in two adjacent borings located downgradient from the Budd Ponds as described by Todd (2017c). The wells (Morgan Park 1 through Morgan Park 5[1]) are screened at five discrete intervals between 90 and 390 feet below ground surface (ft-bgs) as described in **Table 1**. The aquifer system extends deeper; however, given that these wells are located relatively close to the spreading grounds and the Los Gatos GRRP is a surface spreading project, it was determined that deeper screens were unlikely to receive GRRP water or would only receive GRRP water after an extended time period not suitable for early warning. **Table 1** shows the model predicted travel time for each screened interval. As shown in the table, only the two shallower screened intervals (Morgan Park 4 and 5) are predicted to receive recycled water in two months, while the three deeper intervals are predicted to receive recycled water in about 10 or more years.

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[1] The well naming convention presented in this report is similar to other District multi-completion monitoring sites, with "1" representing the deepest screen interval (e.g., Morgan Park 1). It should be noted that this differs from the State Well logs filed with DWR for these wells, where the well numbering is reversed, with 1 representing the shallowest screen interval and the numbers increasing with depth.

Table 1 Completed Morgan Park Monitoring Wells

Well Location	Well Name[a]	District Number	Perforated Interval (ft-bgs)	Aquifer	Model Predicted Travel Time
John D. Morgan Park	Morgan Park 5	07S01W34G002	90-105	Shallow	2 months
	Morgan Park 4	07S01W34G003	132-147	Shallow	2 months
	Morgan Park 3	07S01W34G005	210-230	Deep	~10 years
	Morgan Park 2	07S01W34G004	275-295	Deep	>10 years
	Morgan Park 1	07S01W34G006	270-390	Deep	>10 years

a - The well naming convention presented in this report is similar to other District multi-completion monitoring sites, with "1" representing the deepest screen interval (e.g., Morgan Park 1). It should be noted that this differs from the State well logs filed with DWR for these wells, where the well numbering is reversed, with 1 representing the shallowest screen interval and the numbers increasing with depth.

Per the DDW regulations, travel times are to be confirmed with tracer testing following project startup or under conditions simulating project operations. If model predicted travel times are confirmed for the deeper wells, the District may consider not including these deeper wells in the DDW-required monitoring program, as they will not provide an early warning of potential off-specification recycled water.

This monitoring plan also supports the following District Board Ends Policies:

2.1.1. Aggressively protect groundwater from the threat of contamination and maintain and develop groundwater to optimize reliability and to minimize land subsidence and salt water intrusion.
2.1.4. Protect, maintain, and develop recycled water.

The District will incorporate IPR groundwater monitoring into its ongoing, countywide groundwater monitoring programs to ensure that recycled water is leveraged to improve water supply sustainability while also ensuring protection of groundwater quality.

Figures 1, **2** and **3** show the modeled travel times for the three potential GRRPs, the nearest downgradient drinking water supply well(s), and the areas recommended for monitoring well installation based on the 2-week to 6-month modeled travel time, for the Los Gatos Ponds, Injection Wells and Ford Ponds GRRPs, respectively. The recommended areas do not consider land availability for the wells, which will be considered once the GRRPs are further vetted. **Figure 1** also shows the location of the existing Morgan Park monitoring wells. Note that in some cases the model particle tracking does not start exactly at the edge of the spreading grounds or injection well. This is due to the size of the model grid cells.

As shown in **Figure 1**, the nearest potable supply wells to the Los Gatos Ponds GRRP are 07S01W27Q001 and 07S01W27P009 and the Morgan Park 4 and 5 wells are located in the 2-week to 6-month travels zone. Note that Morgan Park Wells 1, 2, and 3 have travel times close to or greater than 10 years due to the vertical travel time required to reach those screen depths.

Figure 2 shows the nearest potable supply wells to the 16 potential recycled water injection wells for the Injection Well GRRP and all or portions of the 10-year particle paths. Most pathways do not reach potable supply wells in 10-years. The nearest wells are located in a well field located south of Highway 28 and west of San Tomas Expressway. Given that the injection well sites are still preliminary and injection and well field pumping may change, the nearest downgradient production wells potentially include several wells in the well field (07S01W22E009, 07S01W22F001, 07S01W22E011, 07S01W22C004, 07S01W22E014, and 07S01W22E013). It is recommended that travel time simulations be rerun once the Injection Well GRRP is more well defined in terms of injection well locations and injection rates. Monitoring wells should be installed immediately downgradient of the injection/pumping well pair with the shortest travel time within the DDW-required travel time distances. Note that some of the particle pathways cross. This is thought to be due to complexities resulting from grid cell effects and local pumping and injection well influences.

For the potential Ford Ponds GRRP (see **Figure 3**), there are several potable supply wells located near the project, some which may need to be destroyed or decommissioned due to their proximity based on the response retention time (RRT). The RRT for Ford Ponds GRRP (or the other GRRPs) has not yet been established, but will likely be between the minimum 2-month time established in §60320.124 and 6 months, based on other existing GRRPs in California. Well 08S02E08Q002 is located less than one month travel from the spreading grounds and would likely need to be destroyed. Similarly, Well 08S02E08G002 is located just east of the spreading grounds and while the illustrated particle paths do not intercept the wells, if the particles were released in a denser array, it appears the well would be about two to three months travel from the GRRP and may also need to be destroyed. Two wells are identified as the nearest potable water supply well; 08S02E08M007 and 08S02E07H004, each with an associated recommended monitoring well siting area. Note that some of the particle flow paths for the Ford Ponds GRRP cross. This is because particle flow paths are shown for multiple model layers and the layers have different flow pathways from the ponds.

As of this report, the three potential GRRP projects are still undergoing feasibility assessment. While the area of the Los Gatos and Ford Ponds are established, the locations of injection wells have considerable uncertainty and locations may change. Accordingly, the recommended monitoring well locations for the Los Gatos and Ford Ponds GRRPs provide a preliminary conceptual approach for monitoring well siting and it is recommended that the travel time simulations for the injection wells be run again once more accurate injection well locations and injection rates are established.

2.2 Well Owner Notification

DDW regulations require that public water systems and drinking water well owners having downgradient sources of water potentially affected by the GRRP and within 10 years travel time from the GRRP shall be notified by direct mail and/or electronic mail of the availability of the GRRP Monitoring Report. Well owners within 10 years travel time from the GRRP are also to be notified of the public hearing and information repository presenting information about the GRRP. **Figures 4**, **5**, and **6** show 10-year particle paths for the Los Gatos Ponds, Injection Well and Ford Ponds GRRPs, respectively. **Table 2** provides a list of identified potable water supply wells within 10 years travel from each GRRP. Given the modeling uncertainties, in some cases, where wells are close to but just outside the 10-year flow paths, they have been included in the table.

Table 2 Potable Supply Wells Near or Within 10 Years Travel Time from the GRRPs

Injection Wells	Los Gatos Ponds	Ford Ponds
07S01W22E13	07S01W27P09	08S02E8G02
07S01W22C04	07S01W27Q01	08S02E8C07
07S01W22E12	07S01W27P10	08S02E8C09
07S01W22E14		08S02E8Q02
07S01W22F01		08S02E8M07
07S01W22E09		08S02E7H04
		08S02E7G01
		08S02E7A12
		08S02E6R08
		08S01E01J02
		08S02E06M10
		08S01E12D10

2.3 General Groundwater Quality Constituent Monitoring Provisions

General groundwater monitoring provisions are summarized below:

- Groundwater samples will be analyzed using DDW-approved drinking water analytical methods as described in 40 CFR Part 141.
- When practicable or feasible, analytical methods will be selected that provide reporting limits (RLs) lower than the limitations or goals prescribed.
- Upon request by the District in consultation with the DDW and San Francisco Bay Regional Water Quality Control Board (SFBRWQCB), RLs may be established, in any of the following situations:
    - When the constituent has no established method under 40 CFR 141;

    - When the 40 CFR Part 141 method for the pollutant has a reporting limit (RL) higher than the limit specified in the Water Reclamation Requirements (WRRs) issued by the SFBRWQCB for the GRRP; or
    - When the participating agencies agree to use a test method that is more sensitive than those specified in 40 CFR Part 141.
- For regulated constituents, the laboratory conducting the analyses will be certified by the Environmental Laboratory Accreditation Program (ELAP) or approved by DDW or SFBRWQCB, for a particular pollutant or parameter.
- Samples will be analyzed within allowable holding time limits as specified in 40 CFR Part 141.
- Analyses for chemicals other than those with primary maximum contaminant level (MCLs) and secondary MCLs will be selected based on the following approach:
    - Use drinking water methods, if available;
    - Use DDW-recommended methods for unregulated chemicals, if available;
    - If there is no DDW-recommended drinking water method for a chemical, and more than a single USEPA-approved method is available, the most sensitive of the USEPA approved methods will be used;
    - If there is no USEPA approved method for a chemical, and more than one method is available from the scientific literature and commercial laboratory, after consultation with DDW, use the most sensitive method; or
    - If no approved method is available for a specific chemical, the laboratory may develop or use its own methods and will provide the analytical methods to DDW for review. Those methods may be used until DDW-recommended or USEPA-approved methods are available;
    - If the only method available for a chemical is for wastewater analysis (e.g., a chemical listed as a priority pollutant only), that chemical will be sampled and analyzed using wastewater methods specified in 40 CFR Part 136. This approach will be used until a DDW-recommended or USEPA-approved drinking water method is available.
- For constituents of emerging concern (CECs) subject to the SWRCB's Recycled Water Policy, monitoring shall use analytical methods selected to achieve the RLs included in Table 1 of Attachment A of the Recycled Water Policy as amended on January 22, 2013 (SWRCB Resolution No. 2013-0003). The analytical methods will be based on methods published by USEPA, methods certified by the DDW, or peer reviewed and published methods that have been reviewed by DDW, including those published by voluntary consensus standards bodies such as the Standards Methods Committee and the American Society for Testing and Materials (ASTM) International. Any modifications to the published or certified methods shall be reviewed by DDW and subsequently submitted to SFBRWQCB in an updated quality assurance project plan.

- For DDW-specified chemical analyses completed in a month, the District must ensure that the laboratory electronically submits results to DDW no later than 45 days after the end of the month in which monitoring occurred, in a manner such that data are readily uploaded to the DDW database. Utilization of the process is described on the DDW website (https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/EDT.shtml). While submittal to the GeoTracker online database is not specified in the DDW regulations, this electronic upload is typically required in the WRRs issued by the local RWQCB.

2.4 Pre-Operational Groundwater Monitoring Program

In accordance with §60320.100 and §60320.200, the District shall collect at least four quarterly groundwater samples from each GRRP monitoring program well prior to operating the GRRP. The purpose of these groundwater samples is to assess background groundwater quality in each potentially affected aquifer, including any seasonal water quality variability. The samples will be representative of the groundwater in each aquifer expected to receive GRRP water and will be analyzed for the general categories of parameters listed in **Table 3**. **Tables 4** through **11** provide lists of the individual chemicals required by the DDW regulations or recommended by the author in consultation with the District. **Table 12** provides a list of the CECs required for monitoring by the SWRCB's Recycled Water Policy (2013). Note that the Science Advisory Panel for Recycled water is currently evaluating additional CEC monitoring recommendations. Their updated final report is currently scheduled for submittal to SWRCB in February 2018. **Table 13** includes perfluoroalkyl and polyfluoroalkyl substances (PFASs). While these constituents are not currently required regulatory monitoring parameters, they are emerging contaminants of concern and are recommended for baseline sampling to establish their presence or absence in ambient groundwater samples, and because they can occur in recycled water, are detected at some environmental release sites and may be added to future monitoring requirements. **Table 14** provides the recommended reporting limits and water quality objective for each monitored constituent.

Each sample must be analyzed for nitrogen compounds, regulated contaminants, physical characteristics, total organic carbon, constituents with primary and secondary maximum contaminant levels, priority toxic pollutants and any other additional contaminants specified by DDW and/or SFBRWQCB taking into consideration the groundwater basin quality, the source control inventory and the results of the recycled water monitoring at the treatment plant.

Note that the local RWQCB typically specifies the constituents required for monitoring and the reporting limits in the WRRs issued for each GRRP. The list is typically developed based on ambient groundwater quality, the characteristics of the recycled water and consultation among the local RWQCB, DDW and Project Sponsor. The WRRs may include constituents not in the DDW and SWRCB regulations or may exclude constituents that are not observed in the background groundwater and/or recycled water. Consultation with DDW and SFBRWQCB is recommended prior to initiating the pre-operational groundwater monitoring program.

Table 3 IPR Monitoring Program

Constituents/Parameters	Units	Type of Sample	Minimum Frequency of Analysis
Water level elevation[a]	ft-msl	---	Quarterly
Chlorine residual (field)	mg/L	Grab	Quarterly
TOC	mg/L	Grab	Quarterly
Total coliform	MPN/100mL	Grab	Quarterly
Nitrate as N	mg/L	Grab	Quarterly
Nitrite	mg/L	Grab	Quarterly
Total nitrogen[b]	mg/L	Grab	Quarterly
Sulfate	mg/L	Grab	Quarterly
Chloride	mg/L	Grab	Quarterly
TDS	mg/L	Grab	Quarterly
TSS	mg/L	Grab	Quarterly
Inorganics with Primary MCLs[c]	µg/L	Grab	Quarterly
Constituents with Secondary MCLs[d]	---	Grab	Annually
Radioactivity[e]	pCi/L	Grab	Quarterly
Remaining Regulated Organics[f]	µg/L	Grab	Quarterly
Disinfection Byproducts[g]	µg/L	Grab	Quarterly
Remaining General Physical and General Minerals[h]	---	Grab	Annually
Remaining Chemicals with NLs[i]	µg/L	Grab	Quarterly
Remaining Priority Pollutants[j]	µg/L	Grab	Quarterly or Annually
Constituents of Emerging Concern[k]	---	Grab	Quarterly
Polyfluoroalkyl Substances[l]	µg/L	Grab	Not required parameters, initial quarterly samples recommended

TOC – total organic carbon
TDS – total dissolved solids
TSS – total suspended solids
mg/L – milligrams per liter
µg/L – micrograms per liter
pCi/L – picocuries per liter
MPN/100 mL – most probable number per 100 milliliters
MCLs – maximum contaminant levels
NLs – notification levels
ft-msl – feet mean sea level

a - Water level elevations shall be measured to the nearest 0.01 foot and referenced to mean sea level

b - Total nitrogen includes Nitrate-N, Nitrite-N, Ammonia-N, and Total Kjeldahl Nitrogen (TKN)

c - For specific constituents to be monitored, refer to **Table 4**

d - For specific constituents to be monitored, refer to **Table 5**

e - For specific constituents to be monitored, refer to **Table 6**

f - For specific constituents to be monitored, refer to **Table 7**

g - For specific constituents to be monitored, refer to **Table 8**

h - For specific constituents to be monitored, refer to **Table 9**

i - For specific constituents to be monitored, refer to **Table 10**

j - For specific constituents to be monitored and their frequency, refer to **Table 11**

k-For specific constituents to be monitored and their frequency, refer to **Table 12**

l - Polyfluoroalkyl substances are not currently required by DDW or SWRCB regulations, but are recommended for baseline sampling by the authors. For specific constituents to be monitored, refer to **Table 13**

Table 4 Inorganic Chemicals with Primary MCLs

Constituents		
Aluminum	Cadmium	Fluoride
Antimony	Chlorite	Mercury
Arsenic	Chromium, Total	Nickel
Asbestos[a]	Chromium, Hexavalent[b]	Perchlorate
Barium	Copper	Selenium
Beryllium	Cyanide	Thallium

a - If 4 consecutive quarterly results for asbestos are less than the detection limit (0.2 MFL >1 0 µm), monitoring frequency may be reduced to once every 3 years.

b – The hexavalent chromium MCL was invalidated by the Superior Court of Sacramento County on May 31, 2017 but is recommended for inclusion in the monitored parameters

MCLs – maximum contaminant levels

Table 5 Constituents with Secondary MCLs

Constituents		
Aluminum	Manganese	Thiobencarb
Chloride	Methyl-tert-butylether (MTBE)	Total Dissolved Solids
Color	Odor Threshold	Turbidity
Copper	Silver	Zinc
Foaming Agents (MBAS)	Specific Conductance	
Iron	Sulfate	

MCL – maximum contaminant level

Table 6 Radioactivity

Constituents		
Combined Radium-226 and Radium-228	Tritium	Gross Beta Particle Activity
Gross Alpha Particle Activity (Including Radium-226 but Excluding Radon and Uranium)	Strontium-90	Uranium

Table 7 Regulated Organic Chemicals

Constituents		
Volatile Organic Compounds	1,1,2-Trichloroethane (1,1,2-TCA)	Endothal
Benzene	Trichloroethylene (TCE)	Endrin
Carbon Tetrachloride (CTC)	Fluorotrichloromethane (Freon 11)	Ethylene Dibromide (EDB) or (1,2-Dibromomethane)
1,2-Dichlorobenzene (1,2-DCB)	1,1,1-Trichloroethane (1,1,1-TCA)	Glyphosate
1,4-Dichlorobenzene (1,4-DCB)	1,1,2-Trichloro-1,2,2-Trifluoroethane (Freon 113)	Heptachlor
1,1-Dichloroethane (1,1-DCA)	Vinyl Chloride	Heptachlor Epoxide
1,2-Dichloroethane (1,2-DCA)	Xylenes (m,p)	Hexachlorobenzene
1,1-Dichloroethylene (1,1-DCE)	**Non-Volatile Synthetic Organic Compounds**	Hexachlorocyclopentadiene
Cis-1,2-Dichloroethylene	Alachlor	Lindane
Trans-1,2-Dichloroethylene	Atrazine	Methoxychlor
Dichloromethane (Methylene chloride)	Bentazon	Molinate
1,2-Dichloropropane	Benzo(a)pyrene	Oxamyl
1,3-Dichloropropene (1,3-DCP)	Carbofuran	Pentachlorophenol
Ethylbenzene	Chlordane	Picloram
Methyl Tert Butylether (MTBE)	Dalapon	Polychlorinated Biphenyls (PCBs)
Monochlorobenzene (Chlorobenzene)	1,2-Dibromo-3-chloropropane (DBCP)	Simazine
Styrene	2.4-Dichlorophenoxyacetic acid (2,4-D)	Thiobencarb
1,1,2,2-Tetrachloroethane	Bis(2-ethylhexyl)adipate	Toxaphene
Tetrachloroethylene (PCE)	Bis(2-ethylhexyl)phthalate	2,3,7,8-TCDD (Dioxin)
Toluene	Dinoseb	2,4,5-TP (Silvex)
1,2,4-Trichlorobenzene	Diquat	

Table 8 Disinfection Byproducts

Constituents		
Total Trihalomethanes (TTHM)	Haloacetic acid (five) (HAA5)	Dibromoacetic acid
Bromodichloromethane	Monochloroacetic acid	Bromate
Bromoform	Dichloroacetic acid	Chlorite
Chloroform	Trichloroacetic acid	
Dibromochloromethane	Monobromoacetic acid	

Table 9 Recommended General Physical and General Mineral Parameters

Constituents		
Bicarbonate (as HCO_3)	Fluoride	MBAS
Bicarbonate Alkalinity (as $CaCO_3$)	Iron	Odor
Carbonate (as CO_3)	Magnesium	Field pH
Carbonate Alkalinity (as $CaCO_3$)	Manganese	Field Turbidity
Calcium	Nitrate (as Nitrogen)	Specific Conductance
Chloride	Potassium	Total Dissolved Solids (TDS)
Hydroxide (as OH)	Sodium	Total Hardness
Hydroxide Alkalinity (as $CaCO_3$)	Sulfate	
Total Alkalinity (as $CaCO_3$)	Zinc	
Calcium	Color	
Chloride	Hardness	

a – This list is longer than the DDW-required list to support groundwater characterization
DDW – Division of Drinking Water

Table 10 Constituents with Notification Levels

Constituents		
Boron	1,4-Dioxane	n-Nitrosodi-n-propylamine (NDPA)
n-Butylbenzene	Ethylene glycol	Propachlor
sec-Butylbenzene	Formaldehyde	n-Propylbenzene
tert-Butylbenzene	HMX	RDX
Carbon disulfide	Isopropylbenzene	Tertiary butyl alcohol (TBA)
Chlorate	Manganese	1,2,3-Trichloropropane (1,2,3-TCP)
2-Chlorotoluene	4-Methyl-2-Pentanone (MIBK)	1,2,4-Trimethylbenzene
4-Chlorotoluene	Naphthalene	1,3,5-Trimethylbenzene
Diazinon	n-Nitrosodiethylamine (NDEA)	2,4,6-Trinitrotoluene (TNT)
Dichlorodifluoromethane (Freon 12)	n-Nitrosodimethylamine (NDMA)	Vanadium

Table 11 Remaining Priority Pollutants

Constituents		
Pesticides	**Metals**	Di-n-butyl phthalate
Aldrin	Chromium III	Di-n-octyl phthalate
Dieldrin	Lead	Diethyl phthalate
p,p’-DDT	**Base/Neutral Extractables**	Dimethyl phthalate
p,p’-DDE	Acenaphthene	Benzo(a)anthracene
p,p’-DDD	Benzidine	Benzo(b)fluoranthene
Alpha-endosulfan	Hexachloroethane	Benzo(k)fluoranthene
Beta-endosulfan	2-Chloroethyl ether	Chrysene
Endosulfan sulfate	2-Chloronaphthalene	Acenaphthylene
Endrin	1,3-Dichlorobenzene	Anthracene
Alpha-BHC	3,3-Dichlororbenzidine	Benzo(ghi)perylene
Beta-BHC	2,4-Dinitrotoluene	Fluorene
Delta-BHC	2,6-Dinitrotoluene	Phenanthrene
Acid Extractables	1,2-Diphenylhyrazine	Dibenzo(a,h)anthracene
2,4,6-Trichlorophenol	Fluoranthene	Indeno(1,2,3-cd)pyrene
P-Chloro-m-cresol	4-Chlorophenyl phenyl ether	Pyrene
2-Chlorophenol	4-Bromophenyl phenyl ether	**Volatile and Semi-Volatile Organics**
2,4-Dichlorophenol	Bis(2-chloroisopropyl)ether	Acrolein
2,4-dimethylphenol	Bis(2-chloroethoxy)methane	Acrylonitrile
2-Nitrophenol	Hexachlorobutadiene	Chlorobenzene
4-Nitrophenol	Isophorone	Chloroethane
2,4-Dinitrophenol	Nitrobenzene	1,1-Dichloroethylene
4,6-Dinitro-o-cresol	N-nitrosodiphenylamine	Methyl chloride
Phenol	Bis(2-ethylhexyl)phthalate	Methyl bromide
	Butyl benzyl phthalate	2-chloroethyl vinyl ether

Table 12 SWRCB Recycled Water Policy CECs to be Monitored

Constituent[a]	Constituent Group	Relevance/Indicator Type	Reporting Limit (µg/L)
Groundwater Recharge and Reuse – Surface Application			
17β-estradiol	Steroid hormones	Health	0.001
Caffeine	Stimulant	Health & Performance	0.05
N-Nitrosodimethylamine (NDMA)	Disinfection byproduct	Health	0.002
Triclosan	Antimicrobial	Health	0.05
Gemfibrozil	Pharmaceutical	Performance	0.01
Iopromide	Pharmaceutical	Performance	0.05
N,N-Diethyl-meta-toluamide (DEET)	Personal care product	Performance	0.05
Sucralose	Food additive	Performance	0.1
Groundwater Recharge and Reuse – Subsurface Application			
17β-estradiol	Steroid hormones	Health	0.001
Caffeine	Stimulant	Health & Performance	0.05
NDMA	Disinfection byproduct	Health & Performance	0.002
Triclosan	Antimicrobial	Health	0.05
N,N-Diethyl-meta-toluamide (DEET)	Personal care product	Performance	0.05
Sucralose	Food additive	Performance	0.1

µg/L – micrograms per liter SWRCB – State Water Resources Control Board

CECs – constituents of emerging concern

a - Monitoring frequency is quarterly for the initial assessment phase, semi-annually for the baseline phase, and semi-annually to annually for the standard operation phase; CECs can be removed or monitoring can increase based on the results

Table 13 Polyfluoroalkyl/Perfluoroalkyl Substances

Constituents	
Perfluorobutanesulfonic acid	Perfluorononanoic acid
Perfluoroheptanoic acid	Perfluorooctanesulfonic acid
Perfluorohexanesulfonic acid	Perfluorooctanoic acid

Table 14 Recommended Reporting Limits and Water Quality Objectives

Constituent	Recommended Reporting Limit	Units	Primary State MCL	Secondary State MCL	State Notification Level
1,1-Dichloroethane	0.5	µg/L	5		
1,1-Dichloroethylene	0.5	µg/L	6		
1,1,1-Trichloroethane	0.5	µg/L	200		
1,1,2,2-Tetrachloroethane	0.5	µg/L	1		
1,1,2-Trichloro-1,2,2-Trifluoroethane (Freon 113)	5	µg/L	1200		
1,1,2-Trichloroethane	0.5	µg/L	5		
1,2-Dibromo-3-chloropropane	0.01	µg/L	0.2		
1,2-Dichlorobenzene	0.5	µg/L	600		
1,2-Dichloroethane	0.5	µg/L	0.5		
1,2-Dichloropropane	0.5	µg/L	5		
1,2-Diphenylhyrazine	1	µg/L			
1,2,3-Trichloropropane	0.5	µg/L			0.005
1,2,4-Trichlorobenzene	0.5	µg/L	5		
1,3-Dichlorobenzene	0.5	µg/L			
1,3,5-Trimethylbenzene	0.5	µg/L			330
1,4-Dichlorobenzene	0.5	µg/L	5		
1,4-Dioxane	0.07	µg/L			1
2-Butanone (MEK)	5	µg/L			
2-Chloroethyl Vinyl Ether	0.5	µg/L			
2-Chloronaphthalene	1	µg/L			
2-Chlorophenol	1	µg/L			
2-Chlorotoluene	1	µg/L			140
2-Nitrophenol	1	µg/L			
2,3,4-Trichlorophenol	5	µg/L			
2,3,6-Trichlorophenol	5	µg/L			
2,3,7,8-TCDD (Dioxin)	2	pg/L	30		
2,4-Dichlorophenol	1	µg/L			
2,4-Dichlorophenoxyacetic acid (2,4-D)	0.1	µg/L	70		
2,4-Dichlorophenoxyacetic acid (2,4-D)	5	ng/L	70		
2,4-Dimethylphenol	1	µg/L			100
2,4-Dinitrotoluene	1	µg/L			
2,4,5-TP (Silvex)	0.2	µg/L	50		
2,4,5-Trichlorophenol	5	µg/L			
2,4,6-Trichlorophenol	5	µg/L			
2,4,6-Trinitrotoluene (TNT)	1	µg/L			1
2,6-Dinitrotoluene	1	µg/L			
3,3'-Dichlororbenzidine	5	µg/L			
3,4,5-Trichlorophenol	5	µg/L			
4-Bromophenyl phenyl ether	1	µg/L			
4-Chlorophenyl phenyl ether	1	µg/L			
4-Chlorotoluene	5	µg/L			140
4-Methyl-2-Pentanone (MIBK)	5	µg/L			120
4-Nitrophenol	5	µg/L			
Acenaphthylene	1	µg/L			
Acrolein	5	µg/L			
Acrylonitrile	5	µg/L			
Alachlor	1	µg/L	2		
Aldrin	0.01	µg/L			
Alpha, Gross (+/- adjusted gross error)	3	pCi/L	15		
Alpha-BHC	0.1	µg/L			
Alpha-endosulfan	0.05	µg/L			
Aluminum	20	µg/L	1000	200	
Ammonia Nitrogen	0.05	mg/L			
Anthracene	1	µg/L			
Antimony	1	µg/L	6		
Antimony	2	µg/L	6		
Apparent Color	3	ACU		15	
Arsenic	1	µg/L	10		
Asbestos	0.2	MFL			
Atrazine	0.05	µg/L	1		
Barium	2	µg/L	1000		
Bentazon	2	µg/L	18		
Benzene	0.5	µg/L	1		
Benzidine	10	µg/L			
Benzo(a)anthracene	1	µg/L			
Benzo(a)pyrene	0.02	µg/L	0.20		
Benzo(b)fluoranthene	1	µg/L			
Benzo(ghi)perylene	2	µg/L			
Benzo(k)fluoranthene	1	µg/L			
Beryllium	1	µg/L	4		
Beta, Gross (+/- adjusted gross error)	3	pCi/L	50		

Table 14 Recommended Reporting Limits and Water Quality Objectives (continued)

Constituent	Recommended Reporting Limit	Units	Primary State MCL	Secondary State MCL	State Notification Level
Beta-BHC	0.1	µg/L			
Beta-endosulfan	0.05	µg/L			
Bicarbonate Alkalinity (as $CaCO_3$)	2	mg/L			
Bicarbonate as HCO_3, Calculated	2	mg/L			
Biochemical Oxygen Demand	1	mg/L			
Bis(2-chloroethoxy)methane	1	µg/L			
Bis(2-chloroisopropyl)ether	1	µg/L			
Bis(2-ethylhexyl)adipate	5	µg/L			
Bis(2-ethylhexyl)phthalate	5	µg/L			
Boron	0.05	mg/L			1
Bromate	5	µg/L	10		
Bromodichloromethane	0.5	µg/L	80[b]		
Bromoethane	0.5	µg/L			
Bromoform	0.5	µg/L	80[b]		
Bromomethane (Methyl Bromide)	0.5	µg/L			
Butyl Benzyl Phthalate	1	µg/L			
Cadmium	0.5	µg/L	5		
Calcium	1	mg/L			
Carbofuran	2	µg/L	18		
Carbon Disulfide	0.5	µg/L			160
Carbon Tetrachloride	0.5	µg/L	0.5		
Carbonate as CO_3, Calculated	2	mg/L			
Chemical Oxygen Demand	5	mg/L			
Chlorate	10	µg/L			800
Chlordane	0.1	µg/L	0.1		
Chloride	2	mg/L		500	
Chloride	5	mg/L		500	
Chlorine residual	0.5	mg/L			
Chlorite	10	µg/L			1000
Chlorobenzene	0.5	µg/L	70		
Chloroethane	0.5	µg/L			
Chloroform (Trichloromethane)	0.5	µg/L	80[b]		
Chloromethane (Methyl Chloride)	0.5	µg/L			
Chromium	1	µg/L	50		
Chrysene	1	µg/L			
cis-1,2-Dichloroethylene	0.5	µg/L	6		
cis-1,3-Dichloropropene	0.5	µg/L	0.5		
Color	5	CU			
Copper	2	µg/L	1300	1000	
Cyanide	0.005	mg/L	0.15		
Cyanide	0.025	mg/L	0.15		
Dalapon (qualitative)	1	µg/L	200		
Delta-BHC	0.1	µg/L			
Di(2-Ethylhexyl)phthalate	0.6	µg/L	4		
Diazinon	0.1	µg/L			1.2
Dibenzo(a,h)anthracene	2	µg/L			
Dibromoacetic Acid	1	µg/L	60		
Dibromochloromethane	0.5	µg/L	80[b]		
Dichloroacetic Acid	1	µg/L	60		
Dichlorodifluoromethane	0.5	µg/L			1000
Dieldrin	0.01	µg/L			
Diethyl Phthalate	1	µg/L			
Dimethyl Phthalate	1	µg/L			
Di-n-butyl Phthalate	1	µg/L			
Di-n-octyl Phthalate	1	µg/L			
Dinoseb	0.2	µg/L	7		
Diquat	4	µg/L	20		
Endosulfan Sulfate	0.2	µg/L			
Endothal	45	µg/L	100		
Endrin	0.01	µg/L	2		
Ethylbenzene	0.5	µg/L	300		
Ethylene Dibromide	0.02	µg/L	0.05		
Ethylene Glycol	10	µg/L			14000
Fluoranthene	0.1	µg/L			

Table 14 Recommended Reporting Limits and Water Quality Objectives (continued)

Constituent	Recommended Reporting Limit	Units	Primary State MCL	Secondary State MCL	State Notification Level
Fluorene	1	µg/L			
Fluoride	0.05	mg/L	2		
Fluorotrichloromethane-Freon 11	0.5	µg/L	150		
Formaldehyde	30	µg/L			100
Glyphosate	25	µg/L	700		
Haloacetic acid (five) (HAA5)	1	µg/L	60[a]		
Hardness (as $CaCO_3$)	3	mg/L			
Heptachlor	0.01	µg/L	0.01		
Heptachlor Epoxide	0.01	µg/L	0.01		
Hexachlorobenzene	0.5	µg/L	1		
Hexachlorobutadiene	1	µg/L			
Hexachlorocyclopentadiene	1	µg/L	50		
Hexachloroethane	1	µg/L			
Hexavalent Chromium	0.02	µg/L	10		
Cyclotetramethylenetetranitramine (HMX)	1	µg/L			350
Hydroxide (as hydroxide)	2	mg/L			
Hydroxide Alkalinity (as $CaCO_3$)	2	mg/L			
Indeno(1,2,3-cd)pyrene	2	µg/L			
Iron	0.02	mg/L		0.3	
Isophorone	1	µg/L			
Isopropylbenzene	1	µg/L			770
Lead	0.5	µg/L	15		
Lindane (Gamma-BHC)	0.01	µg/L	0.2		
m,p-Xylenes	0.5	µg/L	1750[c]		
Magnesium	0.1	mg/L			
Manganese	2	µg/L		50	500
Mercury	0.2	µg/L	2		
Methoxychlor	0.05	µg/L	30		
Methyl Blue Active Substances	0.05	mg/L		0.5	
Methyl Bromide	0.5	µg/L			
Methyl Tert Butyl Ether	0.5	µg/L	13	5	
Methylene Chloride	0.5	µg/L	5		
Molinate	2	µg/L	20		
Monobromoacetic Acid	1	µg/L			
Naphthalene	1	µg/L			17
N-Butylbenzene	1	µg/L			260
Nickel	5	µg/L	100		
Nitrate (as nitrate)	0.89	mg/L			10[f]
Nitrate (as nitrogen)	0.2	mg/L	10		
Nitrite (as nitrogen)	0.1	mg/L	1		
Nitrobenzene	1	µg/L			
N-Nitrosodiethylamine	2	ng/L			10
N-Nitrosodimethylamine	2	ng/L			10
N-Nitrosodi-n-propylamine	1	ng/L			10
N-nitrosodiphenylamine	1	µg/L			
N-Propylbenzene	1	µg/L			260
Odor	1	TON			
Organic Nitrogen, Calculated	0.2	mg/L			
Oxamyl	20	µg/L	50		
o-Xylene	0.5	µg/L	1750[c]		
p,p' DDD	0.1	µg/L			
p,p' DDE	0.1	µg/L			
p,p' DDT	0.1	µg/L			
PCB 1232 Aroclor	0.1	µg/L	0.5		
PCB 1242 Aroclor	0.1	µg/L	0.5		
PCB 1248 Aroclor	0.1	µg/L	0.5		
PCB 1254 Aroclor	0.1	µg/L	0.5		
PCB 1260 Aroclor	0.1	µg/L	0.5		
p-chloro-m-cresol	1	µg/L			
p-Dichlorobenzene	0.5	µg/L	5		
Pentachlorophenol	0.04	µg/L	1		
Pentachlorophenol	20	µg/L	1		
Perchlorate	4	µg/L	6		
Perfluorobutanesulfonic Acid	5	ng/L			

Table 14 Recommended Reporting Limits and Water Quality Objectives (continued)

Constituent	Recommended Reporting Limit	Units	Primary State MCL	Secondary State MCL	State Notification Level
Perfluoroheptanoic Acid	5	ng/L			
Perfluorohexanesulfonic Acid	5	ng/L			
Perfluorononanoic Acid	5	ng/L			
Perfluorooctanesulfonic Acid	5	ng/L			
Perfluorooctanoic Acid	5	ng/L			
pH, Field	0.1	Units			
Phenanthrene	0.04	µg/L			
Phenol	5	µg/L			
Phenylacetic Acid	1000	µg/L			
Picloram	0.1	µg/L	500		
Potassium	1	mg/L			
Propachlor	0.2	µg/L			90
Pyrene	1	µg/L			
Radium-226	1	pCi/L	5[g]		
Radium-228	1	pCi/L	5[g]		
Radon	50	pCi/L			
Radon 222, Two Sigma Error	0	pCi/L			
cyclotrimethylenetrinitramine (RDX)	1	µg/L			0.3
sec-Butylbenzene	1	µg/L			260
Selenium	5	µg/L	50		
Silver	0.5	µg/L		100	
Simazine	0.05	µg/L	4		
Sodium	1	mg/L			
Specific Conductance	2	umho/cm		1600	
Strontium 90 (Sub)	0.36	pCi/L	8		
Styrene	0.5	µg/L	100		
Sulfate	1	mg/L		500	
Temperature (field)	-	Degrees Fahrenheit			
Tert-Butylbenzene	1	µg/L			260
Tertiary Butyl Alcohol	5	µg/L			
Tetrachloroethylene	0.5	µg/L	5		
Thallium	1	µg/L	2		
Thiobencarb	1	µg/L	70		
Toluene	0.5	µg/L	150		
Total Alkalinity (as $CaCO_3$)	2	mg/L			
Total Coliform	2	MPN/100 ml			
Total Dissolved Solids	10	mg/L		1000	
Total Nitrogen (Calculated)	0.2	mg/L			
Total Organic Carbon	0.3	mg/L			
Total Suspended Solids	5	mg/L			
Toxaphene	0.5	µg/L	3		
trans-1,2-Dichloroethylene	0.5	µg/L	10		
trans-1,3-Dichloropropene	0.5	µg/L	0.5		
Trichloroacetic Acid	1	µg/L	60		
Trichloroethylene	0.5	µg/L	5		
Tritium (Sub)	190	pCi/L	20000		
Trivalent Chromium	10	µg/L	50[e]		
Turbidity	0.1	NTU		5	
Uranium[d]	0.7	pCi/L	20		
Vanadium	1	µg/L			50
Vinyl chloride	0.3	µg/L	0.5		
Zinc	20	µg/L		5000	

mg/L - milligrams per liter
pCi/L - picocuries per liter
MFL – million fibers per liter
MCL - maximum contaminant level
umho/cm - micromhos per centimeter

µg/L - micrograms per liter
MPN/100 mL – most probable number per 100 milliliters
µm - micrometers
NTU - nephelometric turbidity unit
TON - threshold odor number

ng/L - nanograms per liter
ACU - apparent color unit
CaCO3 - calcium carbonate
CU - color unit

a - MCL is sum of 5 haloacetic acids
b - MCL is sum of total trihalomethane compounds
c - MCL is sum of xylenes
d - radiological trigger analysis
e - MCL for total chromium
f - MCL is nitrate plus nitrite
g - MCL is radium-226 plus radium-228

2.5 Routine Groundwater Monitoring Program

Once the construction of the GRRPs and monitoring wells are completed and recharge activities (including injection and/or spreading) begin, the ongoing groundwater monitoring program described in **Table 3** and associated **Tables 4** through **13** will be implemented for the GRRP monitoring wells.

If the monitoring results indicate that 80% of a nitrate, nitrite or nitrate plus nitrite primary MCL has been exceeded, another sample will be collected for confirmation within 48 hours of receiving the results from the laboratory. If the average of the initial sample and confirmation sample exceeds the nitrate, nitrite or nitrate plus nitrite primary MCL, DDW and the SFBRWQCB will be notified within 24 hours. Recycled water recharge will be discontinued until corrective actions are taken or a determination is made that District's GRRP IPR activities were not responsible for the nitrate or nitrate contamination.

After two years of groundwater monitoring, the District may submit a request to reduce the groundwater monitoring constituents and/or monitoring frequency for specific chemicals for DDW and SFBRWQCB consideration. For each of the wells located within one year travel time from the GRRP, the District must collect at least one sample each quarter after operations begin.

2.6 Sampling Protocols

Groundwater quality sampling typically includes:

1. Pre-field preparations including equipment check, cleaning, instrument calibration, and maintenance;
2. Groundwater level monitoring, either manually or through download of pressure transducer data;
3. Well purging to verify that groundwater samples collected from production wells are representative of freshly extracted groundwater and collection of field parameters to establish that adequate purging has been conducted;
4. Proper purge water handling/disposal; and
5. Collection of water quality samples.

General sampling protocols are described below. Note that the District has Standard Operating Procedures (SOPs) for equipment calibration, well purging, collection of field parameters and water level measurement and water quality sampling. These SOPs are subject to change as equipment, laboratory methods or other factors change. Accordingly, the District SOPs supersede the general protocols described in this section. Established District-approved SOPs and field data collection forms should be used for the groundwater sampling program.

In addition, the WRRs issued by the SFBRWQCB for the GRRPs may require additional analytes and sampling protocols.

2.6.1 Sampling Containers

The laboratory or laboratories performing the groundwater analyses shall supply all necessary pre-cleaned, method-appropriate containers and chemical preservatives, trip blanks, coolers, labels, custody seals, chain-of-custody and shipping forms.

Sample containers need to be constructed of a material compatible and non-reactive with the liquid contained. For each analyte to be monitored, the water quality objective and recommended reporting limit are provided in **Table 14**. The currently recommended analytical method, hold time and general sampling procedures are provided in **Table 15**. Special sampling protocols for selected constituents are provided in **Section 2.6.9**.

2.6.2 Equipment Calibration and Decontamination

This section outlines equipment, calibration and decontamination procedures to be performed prior to sampling and between well sampling points. Field equipment typically includes:

- Water level sounder, steel tape and pressure gage for manual water level and total well depth measurements;
- Temperature, pH, oxidation-reduction potential (ORP), specific conductivity, turbidity and dissolved oxygen (DO) meter(s);
- Sampling pumps, if well is not fitted with a dedicated pump; and
- Disposable filtration cartridges, sampling tubing and bailers.

Some of the other equipment includes a laptop computer used to download water level transducer data and potentially enter data in lieu of paper forms, camera, and cell phone.

Each piece of non-disposable field equipment will typically have a manual describing the recommended calibration and decontamination procedures. Current District SOPs call for initial calibration preceding each sampling event, ongoing calibration performed weekly during multi-week sampling events, and final calibration completed at the end of the field sampling event, regardless of whether measurements were recorded over the span of weeks or days. For example, a one-day sampling event will have an initial and final calibration, while a five-week sampling event will have an initial calibration, five ongoing calibrations, and one final calibration.

Equipment that comes in contact with well water should also be decontaminated between each well. Decontamination is typically conducted by hand washing the equipment with a laboratory grade non-phosphate detergent (e.g., Alconox®) followed by a double rinse with distilled/deionized water and drying with a clean dry paper towel.

Table 15 Summary of Groundwater Monitoring Constituents, Analytical Methods, Hold Times and Special Sampling Protocols

CONSTITUENT	METHOD	HOLD TIME	PROTOCOLS
Nitrosamines	1625M or 521	7 days	Nitrosamines can be present in trace amounts of rubber products, so these components must be avoided in sampling, storage.
Pharmaceuticals and Personal Care Products	1695 ESI+	28 days	Minimize contact with analyzed constituents. See **Table 17** and **Section 2.6.9.1**
Nitrate as Nitrogen	300	48 hours	The bottle should be filled to within one to two inches from the top.
Nitrite as Nitrogen			
Total Kjeldahl Nitrogen	SM4500-NorgB	28 days	
Total Nitrogen (calculated)	calculated	NA	
Coliform	9221, 9222 or 9223	30 hours	Open the bottle (but do not set the cap down), hold the cap by its outside edges only, and fill the sample bottle to just above the 100-mL line leaving a one inch headspace.
Aluminum	200.8	180 days	Field filter if sample turbidity is higher than 10 NTU. The bottle should be filled to within one to two inches from the top.
Antimony			
Arsenic			
Barium			
Beryllium			
Cadmium			
Chromium			
Copper			
Iron			
Manganese			
Mercury[a]	245.1	28 days	
Nickel	200.8	180 days	
Lead			
Selenium			
Silver			
Thallium			
Zinc			
Chromium III	calculated	NA	
Chromium VI	218.6 DW	14 days	
Perchlorate	314	28 days	The bottle should be filled to within one to two inches from the top.
Radium 226	903	180 days	The bottle should be filled to within one to two inches from the top.
Radium 228	Ra-05	180 days	
Gross Alpha	900	5 days	
Gross Beta			
Uranium	908	180 days	
Strontium 90	905	180 days	
Tritium	906	21 days	
Fumigants	504.1	14 days	Field filter if sample turbidity is higher than 10 NTU. Ask the lab how to fill the bottle as this may depend on the bottle in use and the method used for analysis.
NP Pesticides	507	14 days	
OP Pesticides & PCBs	508	7 days	
Herbicides	515.1	14 days	
Carbamate Pesticides	531.1	28 days	
Glyphosate	547	14 days	
Endothall	548.1	7 days	
Diquat	549	7 days	
Thiobencarb	507	14 days	
2,3,7,8-TCDD Dioxin	1613	365 days	
Total Trihalomethanes	524.2	14 days	Slowly fill the bottle by allowing the sample to gently flow down the inside of the bottle. Create a meniscus of water at the mouth so that the bottle is overfilled. Cap the bottle so that no air bubbles are present in the bottle and the excess water spills down the sides of the bottle. Check to make sure that the bottle does not contain bubbles by inverting the bottle several times.
Haloacetic acid (HAA5s)	552	14 days	Fill the bottle to within one to two inches from the top.
Color	SM2120B	48 hours	Rinse the bottle and cap three times with sample water and fill the bottle to within one to two inches from the top.
Odor	140.1	24 hours	Rinse the bottle and cap three times with sample water and fill the bottle to within one to two inches from the top.
Turbidity	SM2130B	48 hours	Rinse the bottle and cap three times with sample water and fill the bottle to within one to two inches from the top.
Foaming Agents	SM5540C	48 hours	Rinse the bottle and cap three times with sample water and fill the bottle to within one to two inches from the top.
Total Dissolved Solids	SM2540C	7 days	
Electrical Conductivity	SM2510B	28 days	Rinse the bottle and cap three times with sample water and fill the bottle to within one to two inches from the top.
Bromate, Chloride, Chlorite, Fluoride, Conductivity, Sulfate	300 or 300.1	28 days	Rinse the bottle and cap three times with sample water and fill the bottle to within one to two inches from the top.
Total Organic Carbon	SM5310C	28 days	The bottle should be filled to within one to two inches from the top.
Volatile Organics	524.2	14 days	Slowly fill the bottle by allowing the sample to gently flow down the inside of the bottle. Create a meniscus of water at the mouth so that the bottle is overfilled. Cap the bottle so that no air bubbles are present in the bottle and the excess water spills down the sides of the bottle. Check to make sure that the bottle does not contain bubbles by inverting the bottle several times.
1,4 -Dioxane	522	7 days	
Methyl-tert-Butylether	524.2	14 days	
Semivolatiles	525	7 days	Field filter if sample turbidity is higher than 10 NTU. The bottle should be filled to within one to two inches from the top.
Polycyclic Aromatic Hydrocarbons	525	7 days	
Polychlorinated Biphenyls	608	7 days	
Asbestos	100.1 or 100.2	48 hours	Rinse the bottle and cap three times with sample water and fill the bottle to within one to two inches from the top.
Cyanide	10-204-00-1X	14 days	The bottle should be filled to within one to two inches from the top.
Perfluoroalkyl Substances	EPA 537[b]	14 days	See **Section 2.6.9.2**.

a - Ultra-low level (ULL) analyses for mercury is required for surface water applications only, generally pertinent to inland waters (e.g., streams) protective to fish (40 CFR Part 131.). For groundwater, mercury analysis by EPA Method 245.1 is sufficient.

b – USEPA expects to have new draft analytical method in fall of 2017

PPCP – pharmaceuticals and personal care products
N – nitrogen
TKN – Total Kjeldahl Nitrogen
L – liter
mL – milliliter
USEPA – United States Environmental Protection Agency
NTU – nephelometric turbidity units
NA – not applicable

2.6.3 Monitoring Well Preventative Maintenance Program

While the District monitors multiple different well types including privately owned supply and monitoring wells, the monitoring wells used for the GRRP program will likely be District-owned and maintained. The structural integrity of the monitoring well casing, seals, and well cap must be maintained in such a way as to prevent surface water and contaminants near the ground surface from entering the well. To prevent 1) unauthorized access or entry into the well, 2) damage to the well and well head from external sources, and 3) the well becoming a conduit for leakage of contamination from the ground surface or shallow subsurface, the condition of the well should be recorded during each sampling event. Any problems that might compromise samples collected from the well should be corrected promptly. If a well problem prevents the well from being sampled, the problem should be fixed as quickly as possible to maintain the sampling frequency approved by DDW and SFBRWQCB.

2.6.4 Groundwater Level Measurements

Prior to any purging or sampling activity at each monitoring well, water level transducer data will be downloaded, if a transducer is installed, and a manual water level measurement will be taken. The District SOP also calls for annual measurement of the total well depth and follow-up if the measured depth does not correspond with the constructed depth.

Water levels will be measured with a precision of ± 0.01 foot. The District convention is to have the reference point for each well established at the ground surface. If the well has a stick up or is completed below the ground surface and the measurement cannot be made relative to the ground surface, a correction is applied to the calculated groundwater elevation.

Some wells in the District are flowing artesian. Typically, these wells are fitted with a dedicated pressure gage to measure the pressure head above the ground surface.

2.6.5 Well Purging

Purging a monitoring well is required prior to sampling. Stagnant water standing in a monitoring well over a period of time between sampling events may be unrepresentative of formation water because of chemical and biochemical changes, which may impact water quality. Monitoring wells may have dedicated pumps installed or purging may be conducted with pumps brought to the field.

The standard purge method involves purging the well of a minimum of three casing volumes and until stabilization criteria have been met and verified by three to five sets of field measurements of pH, temperature, and electrical conductivity. Purge water should be properly containerized and or disposed.

2.6.6 Analysis Collection Order

At each well, samples will be collected according to the volatility of the requested analyses (e.g., the most volatile constituents are collected first). Groundwater samples should be collected at each well in the order indicated in **Table 16**.

Table 16   Groundwater Analyses Collection Order

Collection Order	Analysis
1	Organics including VOCs, SVOCs, PFAS and PPCPs
2	Inorganics (general and trace minerals/ions)
3	Major water quality cations and anions
4	Metals
5	Cyanide
6	Tritium
7	Radionuclides

VOCs – volatile organic compounds SVOCs – semivolatile organic compounds
PFASs - Perfluoroalkyl Substances
PPCPs - Pharmaceutical and Personal Care Products
ELAP - California Environmental Laboratory Accreditation Program
Reference: Cal/EPA-DTSC (2008)

All groundwater sample collection should be conducted using appropriate USEPA or Standard Method (SM) protocol including holding times and chain-of-custody forms.

The following sampling procedures are recommended:

- Sampling procedures as provided in **Table 15** and **Section 2.6.9**
- Samples requiring refrigeration to 4°C will be accomplished by placing the sample containers immediately into coolers containing wet ice or the equivalent and delivering to the analytical laboratory as soon as possible
- All sample containers will be labeled with:
    - Site and well name or number;
    - District name, collector's name (or initials), date, and time of sampling;
    - Project name and number;
    - Unique sample identification number; and
    - Type of preservatives used (if any).

2.6.7 Chain-of-Custody

Proper chain-of-custody records are required to insure the integrity of the samples and the conditions of the samples upon receipt at the laboratory. The sampler shall fill in all applicable sections and forward the original, with the respective sample(s), to the laboratory performing the analysis. Upon receipt of the samples at the laboratory, laboratory personnel will complete the chain-of-custody. The completed chain-of custody form will be included with the laboratory report.

2.6.8 Sample Transport

Samples shall be delivered from the field to the analytical laboratory either by District staff, laboratory currier or utilizing an overnight courier service. Samples are to be shipped in sealed insulated shipping containers which maintain the samples at approximately 4°C. Standard shipping containers must be a sturdy water-proof design (ice chests are commonly used) equipped with bottle dividers and cushion material to prevent breakage during shipment.

2.6.9 Special Sampling Protocols

Sampling protocols are summarized in **Table 15** and described for selected constituents in this section.

2.6.9.1 Sample Protocols for Pharmaceutical and Personal Care Products (PPCPs)

PPCPs analyses are extremely sensitive with analytical results returned in nanogram per liter (ng/L). Therefore, on the day of sampling, analytical laboratories that specialize in the analysis of PPCPs strongly recommend avoidance of the following products either by contact or consumption. If contact or consumption is unavoidable, then collection of field blanks is strongly recommended.

- **Wastewater compounds**, including:
    - Soaps and detergents, including antibacterial cleansers
    - Insect repellents, particularly those with n,n-diethyl-meta-toluamide (DEET)
    - Fragrances (cologne, after shave, perfumes, deodorants)
    - Sunscreens
    - Animal or human urine and/or excrement
    - Caffeine (coffee, tea, and colas)
    - Tobacco
- **Pharmaceutical compounds**
    - Prescription drugs, medications, and hormonal substances
    - Over-the counter medications
    - Selected human and veterinary antibiotics

Table 17 summarizes protocols for sampling PPCPs in groundwater.

Table 17 Summary for Sampling for PPCPs in Groundwater

Sampling Parameters	Requirements
Volume	• Two 80 mL brown round amber glass for proposed list. Second container for field blank, if collected.
Equipment	• Wear powderless nitrile laboratory gloves; change gloves with each change in activity, sample collection, or potential glove contamination. • Avoid breathing on open sample containers. • Avoid direct contact between clothing and sample containers, sampling devices, and processing equipment. Clothing may contain residual detergents, fragrances, and fire retardants. • If sampling from tap: make sure that the tap is free of aerators, strainers, or hose attachments. Flush for 3-5 minutes from a constantly flowing tap to obtain a representative sample. • If not sampling from tap: clean all sampling equipment before use using the following: - Non-antibacterial detergent - Rinse all equipment copiously with deionized water after detergent wash - Follow deionized water rinse with methanol rinse. Collect used methanol solution into an appropriate contained for disposal • Sampling and processing equipment should be made from glass, aluminum, or stainless steel. Avoid equipment made of Tygon™, polyethylene or other plastics.
Containers	• Use laboratory supplied, pre-cleaned containers only. Do not clean or field-rinse laboratory-supplied sample bottles. • For recommended CEC list use the following number of bottles: - two 80 mL amber glass bottles or as provided by laboratory • Fill bottles to the neck, but do not overfill. • Tightly seal all caps
Preservation	• Sodium azide and ascorbic acid • Cool to <6 ^{o}C
Storage Life	• Unknown
Holding Time	• 28 days

2.6.9.2 Sample Protocols for Perfluoroalkyl/Polyfluoroalkyl Substances (PFASs)

PFASs are a class of man-made chemicals. PFASs have been widely used to make products more stain-resistant, waterproof and/or nonstick. For example, PFASs have been used in the manufacture of products that:

- keep food from sticking to cookware;
- make upholstered furniture, carpets and clothing resistant to soil, stains and water;
- make shoes, clothes and mattresses more waterproof;
- keep food packaging from sticking to food; and
- help fight fires at airfields and other places where petroleum-product-based fires are a risk.

Because they help reduce friction, they are also used by a variety of industries such as aerospace, automotive, construction and electronics factories or businesses.

PFASs analyses are extremely sensitive with analytical results returned in ng/L. When sampling for PFASs, it is recommended that the samplers do not wear and/or use:

- Personnel hygiene items (cosmetics, lotions, moisturizers)
- Sunscreens and insect repellants
- New or unwashed clothing
- Clothing washed in fabric softeners
- Treated clothing (waterproof, water resistant, stain-resistant)
- Treated boots (waterproof, water resistant, stain-resistant)
- Coated Tyvek™
- Prepared repackaged food products

Recommended sampling equipment include:

- Disposable dedicated equipment (no fluoropolymer materials);
- High-density polyethylene (HDPE) and silicon materials (i.e. tubing);
- Alconox® and Liquinox® soap for decontamination (water used for the decontamination of sampling equipment should be laboratory certified "PFASs-free");
- Polypropylene or HDPE sample bottles fitted with an unlined (no polytetrafluoroethylene, e.g., Teflon™), polypropylene or HDPE screw cap;
- Loose paper on aluminum clipboards (no waterproof field books);
- Ball point pens (no sharpies or post-it notes);
- Ice contained in plastic (polyethylene) bags (double bagged), secured to avoid meltwater from contacting sample containers, overnight shipping (no blue chemical ice); and
- Thin HDPE sheeting (no aluminum foil).

2.7 Quality Assurance and Quality Control (QA/QC) Samples

QA/QC procedures are intended to ensure that all data and resulting decisions are scientifically valid, defensible, and of known precision and accuracy.

2.7.1 Field QA/QC Samples

Field QA/QC samples include trip, field, and equipment blanks and blind duplicates as described below.

Trip Blank - Trip blanks provide a check on contaminants that may have originated from sample handling and transportation activities and/or in the laboratory. These samples shall be prepared in the laboratory by filling the appropriate clean sample containers with deionized/distilled water and adding any applicable chemical preservative. Containers will be shipped in the typical transportation cooler to the field and back to the laboratory along with the other sample containers. The trip blank will be numbered, packaged and sealed in an identical manner as the other water samples collected and will be carried to the well and set next to the well during sampling along with the empty sample containers. At no time will the trip blank be opened during sampling. Trip blanks will be included with groundwater samples at a rate of one per day.

Field Blank - Field blanks are taken to identify sample contamination that is associated with the field environment and sample handling methods. These samples will be prepared in the field at a routine sample collection point by filling the appropriate sample containers from the field supply of deionized/distilled water. This field supply water shall be the same water used for cleaning and decontamination of all field equipment. Field blanks will be included with groundwater samples at a rate of one per day.

Equipment (Rinsate) Blank – Equipment blanks are used to verify that any non-dedicated equipment that comes in contact with well water is fully decontaminated between wells. For example, if wells do not have dedicated pumps, after decontamination, distilled/deionized water is poured over the pump and collected for analysis. The frequency of equipment blank collection depends on the use of non-dedicated equipment.

Blind Duplicates - Blind duplicates are useful in documenting the precision of the sampling and analytical process. A blind duplicate is a second sample collected from a given location and must be taken concurrently with the primary sample. Two separate samples are taken from the same source, stored in separate containers, packaged, sealed and analyzed in an identical manner as the primary water sample. To prevent special handling of the samples by the laboratory, samples collected for blind duplicate analysis will not be identified to the laboratory as to their primary sample source. Typically, blind duplicates will be collected at the rate of one per sampling event. If duplicate analyses results do not fall within specified control limits, the sample matrix may not be homogeneous or the sampling and analytical procedures may not be capable of providing consistent results. In these cases, actions should be taken to correct the situation and the data should only be used with recognition of its potential lack of precision.

2.7.2 Laboratory QA/QC

The laboratory conducting the analyses must be California State certified per the California Environmental Laboratory Accreditation Program (ELAP) and have in place a documented analytical QA/QC program that includes procedures to reduce variability and errors, identify and correct measurement problems and provide a statistical measure of data quality. The basic requirements for a laboratory QA/QC program are described in the USEPA SW 846 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (last updated January 3, 2008).

The laboratory will conduct all QA/QC procedures in accordance with its QA/QC program. All QA/QC data shall be reported in the laboratory analytical report, including: method, equipment, analytical detection limits, recovery rates, explanation for any recovery rate that is less than 80 percent, results of equipment and method blanks, results of spiked and surrogate samples, frequency of quality control analysis and the name of the person(s) performing the analyses. Sample results shall be reported unadjusted for blank results or spike recovery. In cases where contaminants are detected in QA/QC samples (i.e., field, trip, or equipment blanks), the accompanying sample results shall be appropriately flagged.

2.8 Reporting

Compliance with the requirements of the GRRP WRRs will be evaluated based on the analytical monitoring data. Monitoring reports and protocols will include, but not be limited to, the following:

- Analytical results;
- Location of each sampling point where samples were obtained;
- A map (at a scale of 1 inch equals 2,000 feet) that clearly identifies the locations of spreading grounds or injection wells, monitoring wells and water supply production wells located within two years of travel time from the GRRP;
- Analytical test methods used and the corresponding RLs and method detection limits (MDLs);
- Name(s) of the laboratories that conducted the analyses;
- Copies of laboratory certifications issued through the DDW ELAP will be made available upon request;
- QA/QC documentation, including documentation of chain of custody, will be made available upon request.

No later than six months after the end of each calendar year, the District must submit a report to DDW and SFBRWQCB that provides information including the project compliance status, any corrective actions or suspensions of recycled water applications, monitoring data, the location of the recharged recycled water, changes in operations or treatment and predictions of recycled municipal wastewater contributions (RWCs) for the next calendar year, if less than 100 percent. GRRPs using recycled water treatment processes that can reliably achieve total organic carbon (TOC) concentrations no greater than 0.5 milligrams per liter (mg/L) may receive approval for an initial RWC of 1.0.

Routine monitoring reports submitted to DDW and SFBRWQCB will include any detections of monitored chemicals or contaminants and any temporal trends observed in the monitoring wells. Additionally, information pertaining to the vertical and horizontal migration of the extent of the recycled water plume will also be provided in the monitoring reports.

If applicable, revised estimates of hydrogeologic conditions will be provided in annual reports, including the underground retention time. Significant differences, and the reasons for such differences, between the estimates presented in the approved Engineering Report and subsequently revised estimates, shall be clearly presented.

Public water systems and drinking water well owners with downgradient sources potentially affected by the GRRP and within ten years groundwater travel time from the GRRP must be notified by direct mail and/or electronic mail of the availability of the annual report. **Figures 4**, **5** and **6** show the modeled 10-year particle paths for the Los Gatos, Injection Wells, and Ford Ponds GRRPs, respectively. As shown in **Figure 4**, three potable supply wells are located within the 10-year travel time particle paths at between two and three years' travel time from the Los Gatos Ponds GRRP. Note that near the top of the figure, two potential purified water injection wells are also located within the 10-year travel time. **Figure 5** shows the that six potable supply wells are near the edge of the 10-year travel time for the Injection Wells GRRP. **Figure 6** shows that twelve potable supply wells are located within or near the edge of the 10-year travel time from the Ford Ponds GRRP.

Every five years from the date of the initial approval of the Engineering Report, the District must update the report to address any project changes and submit the report to DDW and the SFBRWQCB. The Five-Year Engineering Report must address anticipated increases in RWC, if applicable, compliance with retention time requirements, descriptions of inconsistencies between previous groundwater modeling predictions and the observed values, and how subsequent predictions will be determined.

3 References

California Environmental Protection Agency, Department of Toxic Substances Control (Cal/EPA-DTSC), 2008 (revised), Representative Sampling of Groundwater for Hazardous Substances Guidance Manual for Groundwater Investigations.

State Water Resources Control Board (SWRCB), 2013. Amendment to the Recycled Water Policy, revised January 22, 2013 and approved April 25, 2013 (Resolution No. 2013-0003). Accessed at: http://www.swrcb.ca.gov/water_issues/programs/water_recycling_policy/index.shtml.

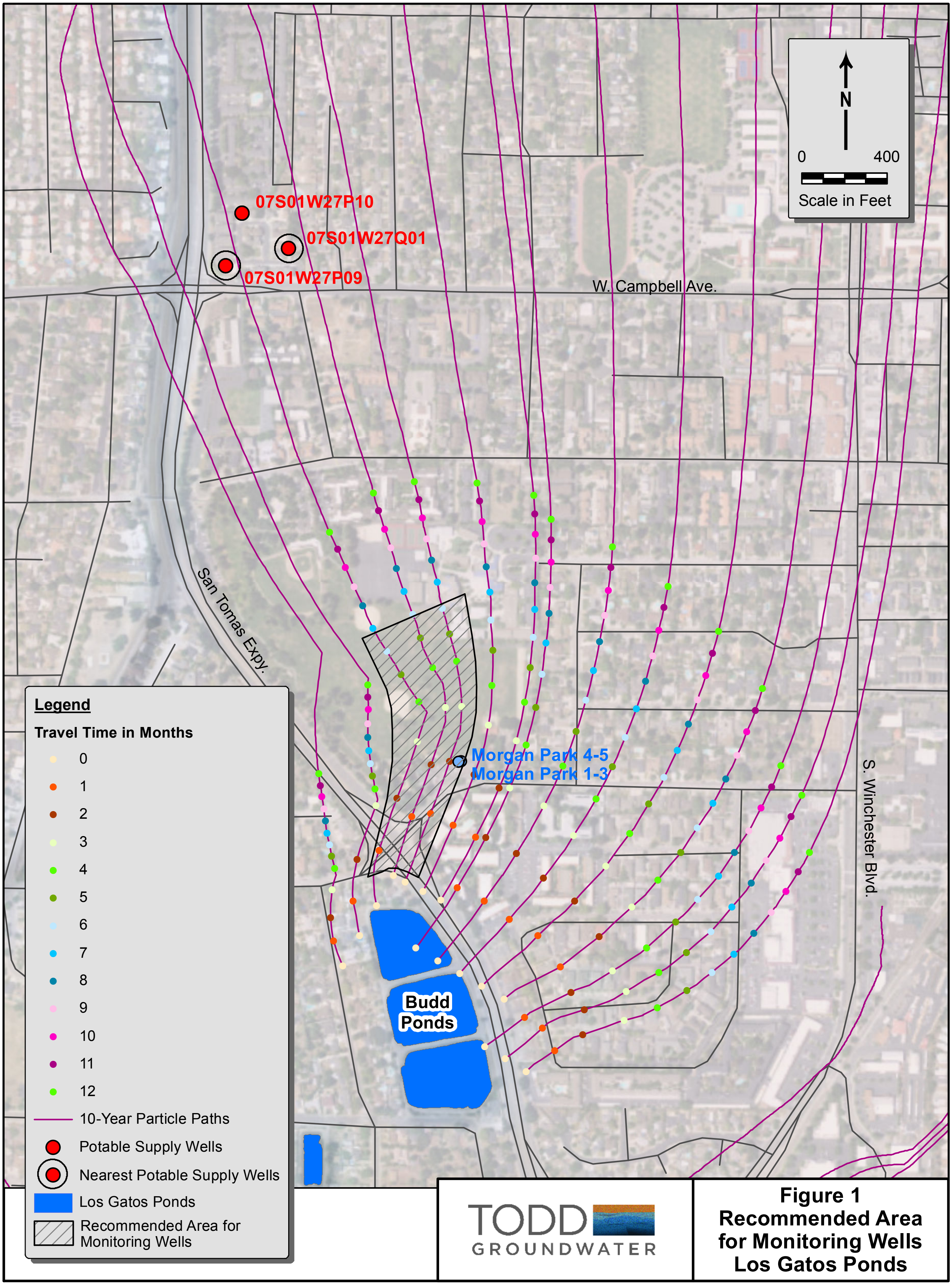
Todd Groundwater (Todd), 2017a, Final Santa Clara Plain Groundwater Flow Model Development and Calibration, Indirect Potable Reuse Groundwater Studies, December.

Todd Groundwater (Todd), 2017b, Final Santa Clara Plain Groundwater Flow Model Scenario Simulations, Indirect Potable Reuse Groundwater Studies, September.

Todd Groundwater (Todd), 2017c, Final Field Work Documentation and Analysis, Indirect Potable Reuse Groundwater Studies, December.

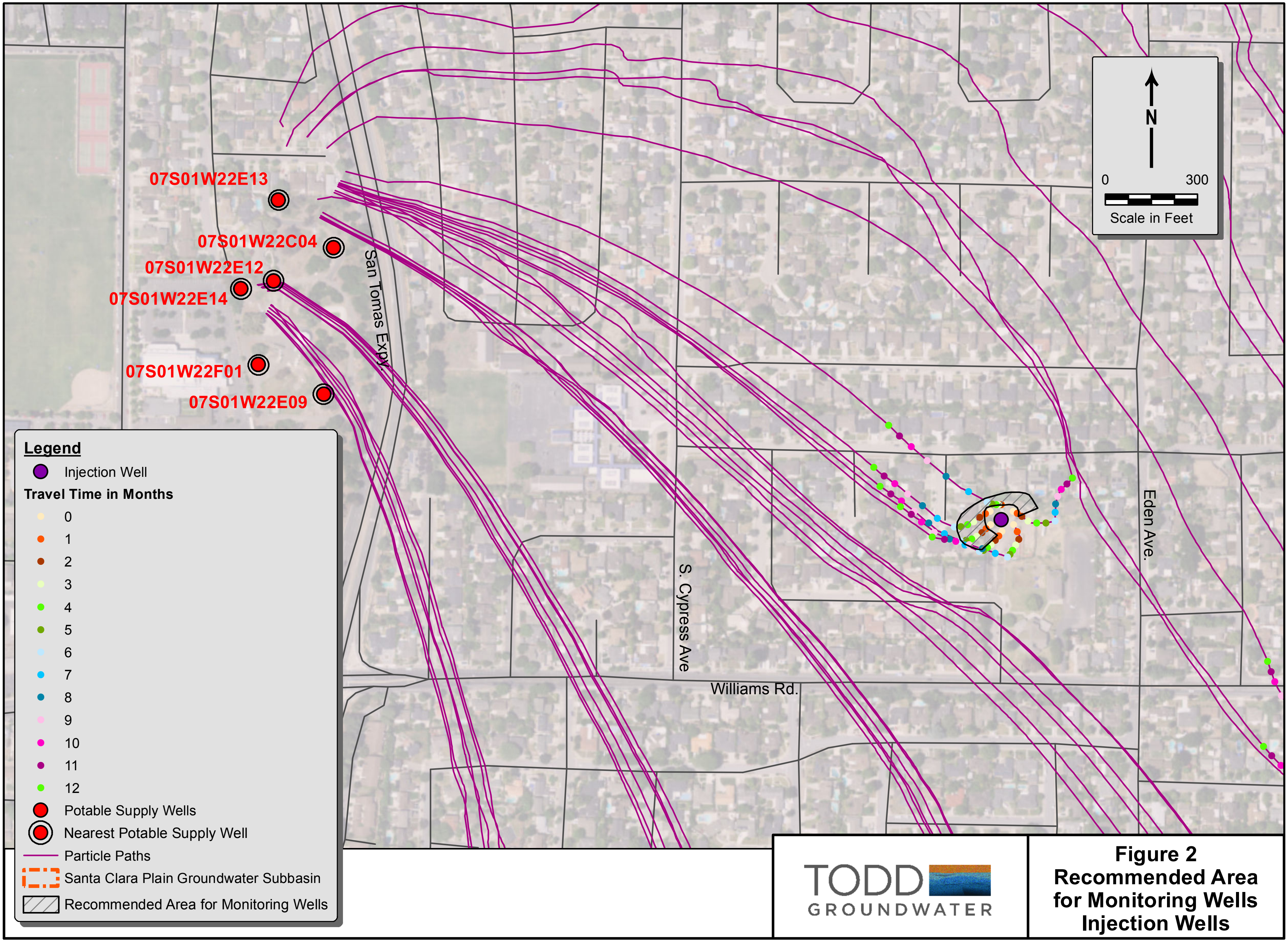
United States Environmental Protection Agency (USEPA), 1986; revised January 3, 2008, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Fourth Edition, SW-846, Office of Solid Waste and Emergency Response, Washington, D.C., November.

Figures



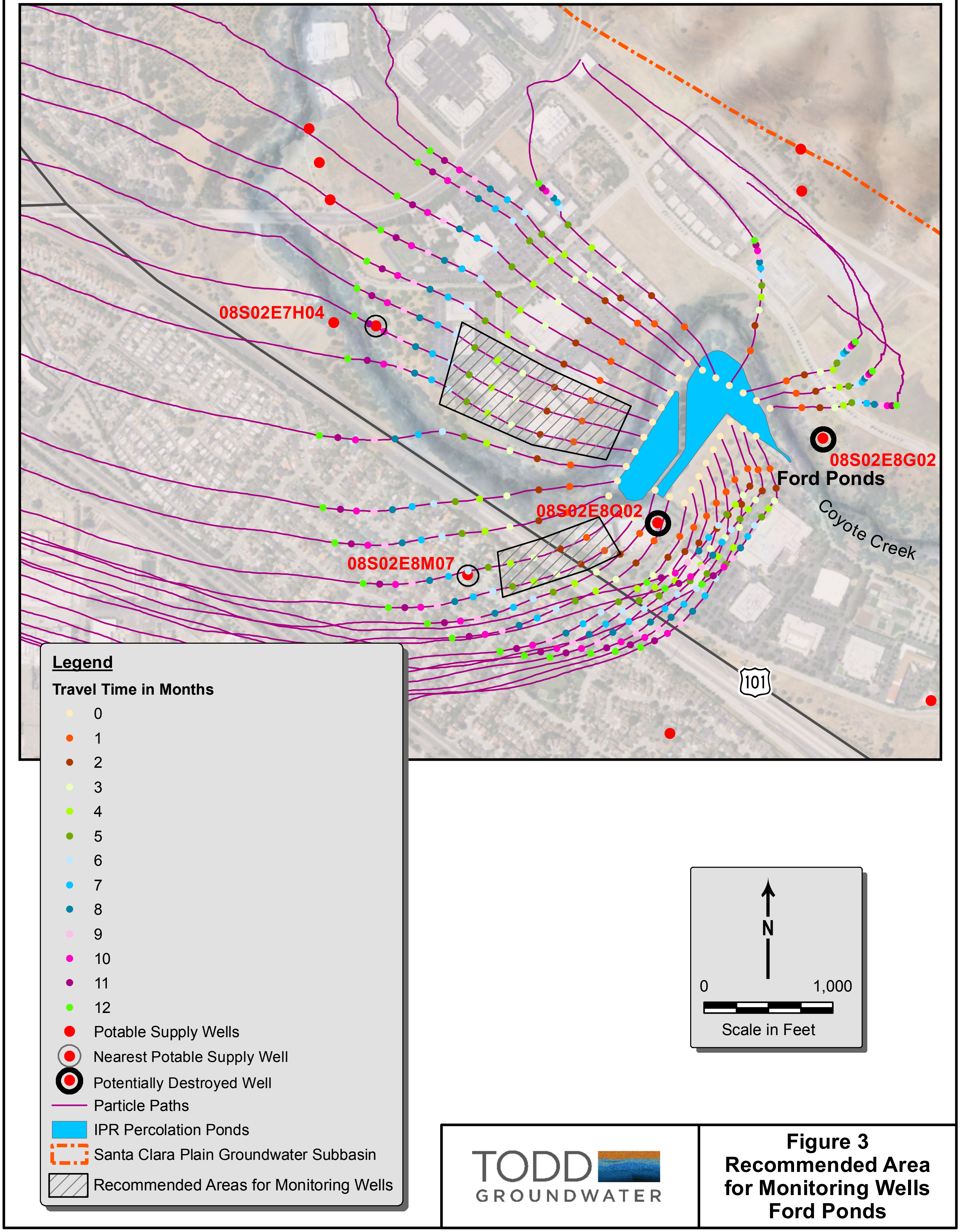
TODD GROUNDWATER

Figure 1
Recommended Area for Monitoring Wells Los Gatos Ponds



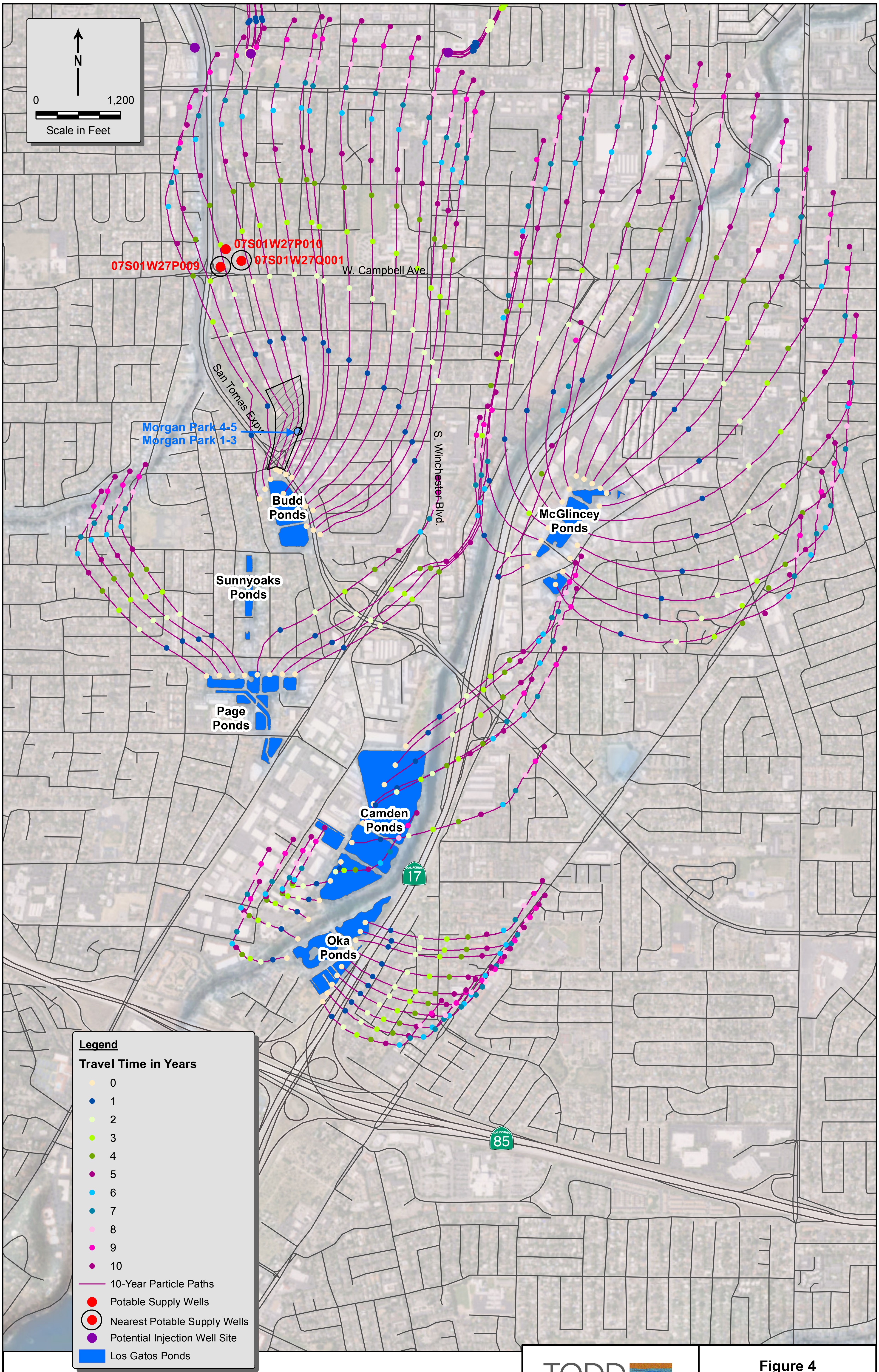
TODD GROUNDWATER

Figure 2
Recommended Area for Monitoring Wells Injection Wells



TODD GROUNDWATER

Figure 3
Recommended Area for Monitoring Wells Ford Ponds



GRRP - Groundwater Replenishment Reuse Project

TODD GROUNDWATER

Figure 4
Los Gatos Ponds GRRP
10-Year Particle Paths

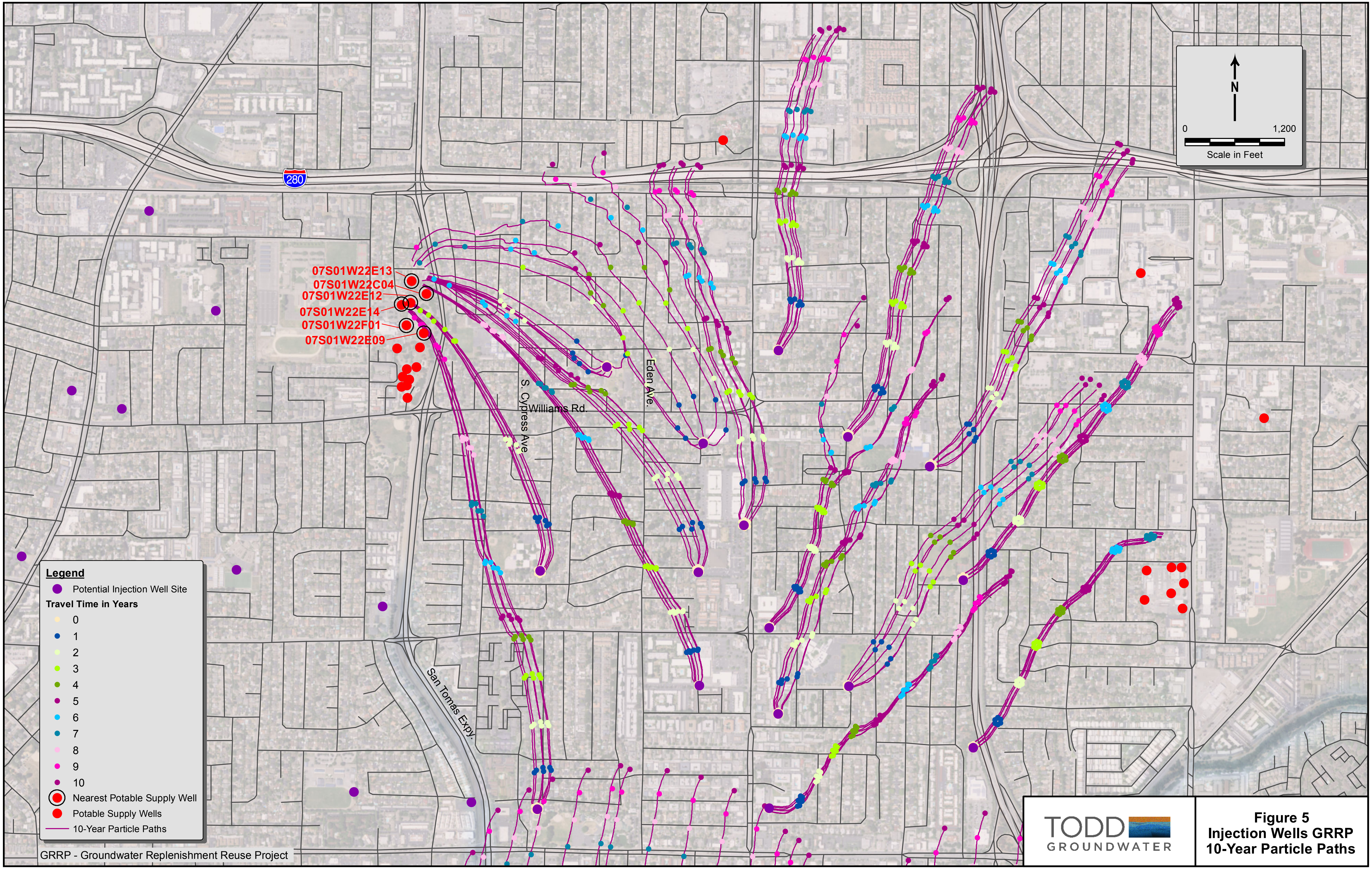
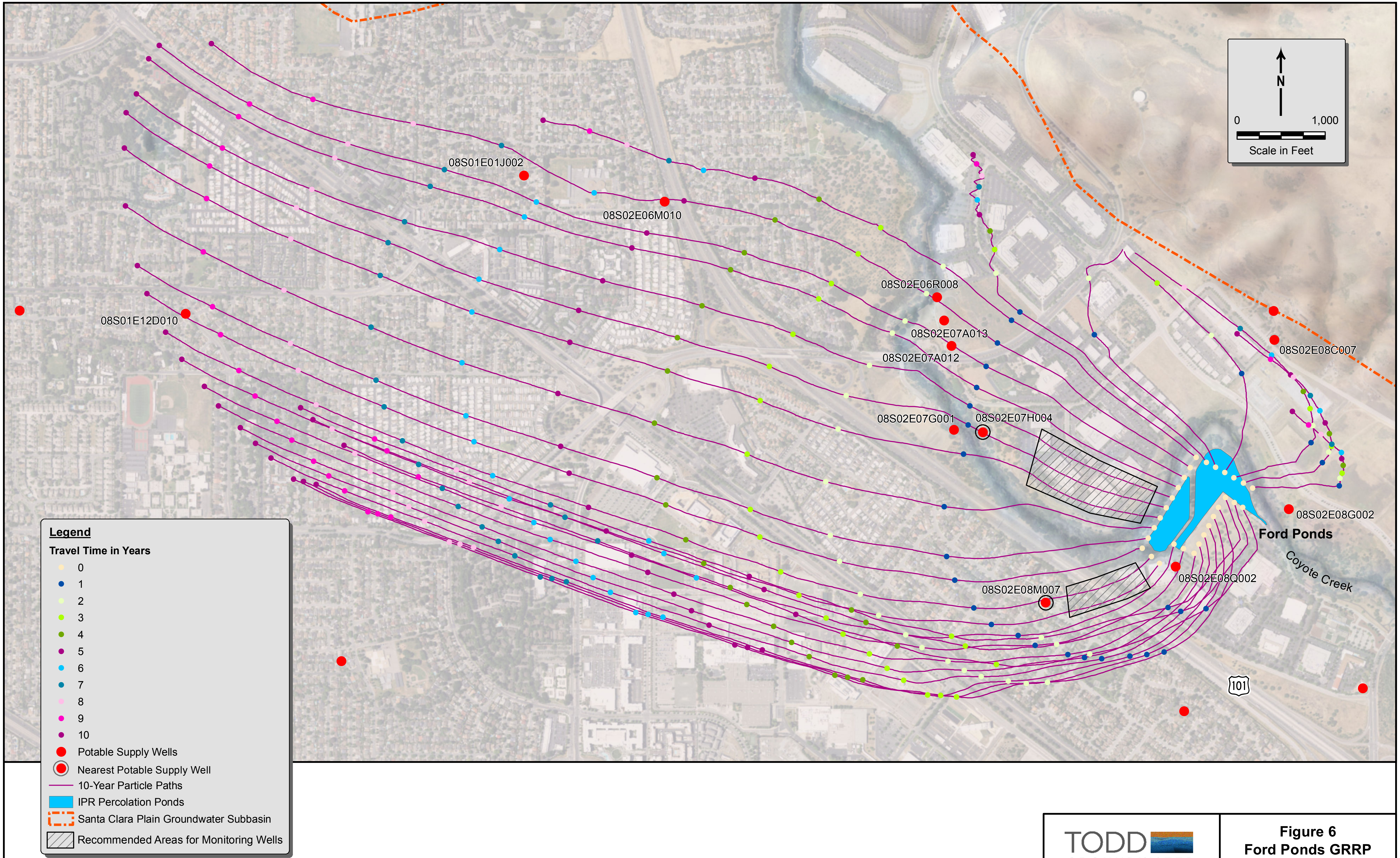


Figure 5
Injection Wells GRRP
10-Year Particle Paths



GRRP - Groundwater Replenishment Reuse Project

TODD GROUNDWATER

Figure 6
Ford Ponds GRRP
10-Year Particle Paths